TABLE 2.1

UPLINK: SYS PARAM		DUAL DIVERSITY CONST.	ELLIPSAT	GLOBAL	ODYSSEY	CELSAT
BIT RATE	KBPS	4.80	4.80	4.80	4.80	5.00
VOICE		0.50	0.50	0.50	0.50	0.50
BANDW.	MHZ	8.25	8.25	7.50	8.25	8.25
DIV LOSS	DB	1.00	1.00	1.00	1.00	1.00
E/(N+I)	DB	4.80	4.50	4.80	4.50	4.80
BEAMS		10.00	10.00	20.00	16.00	149.00
CLUSTER		1.00	1.00	1.00	1.00	1.00
AVG MARG.	DB	1.40	1.40	1.40	1.40	1.40
ORBIT/ANT	DB	2.90	2.00	1.29	1.50	1.70
POW CONT.	DB	1.50	1.00	1.00	1.00	2.00
BOF	DB	1.00	1.00	1.23	1.25	3.80
DY.RANGE	DB	0.00	6.70	9.20	6.10	11.40
MAX MARG.	DB	8.00	8.00	8.00	8.00	8.00
IDEAL CAP		9042	9688	16439	15501	129330
ASYM CAP		1889	2794	5295	4735	16661

SHARED CAPACITY

K	-228.60				
TEMP	500.00	26.99	DB/K		
FREQ	1.6183	GHZ			
GAIN	25.49				
NOISE	-140.10	DBW/M2 IN		4.00	KHZ

	PFD		CONST. LHC	ELLIPSAT RHC	GLOBAL RHC	ODYSSEY LHC	CELSAT LHC	
NO INTER	-140		955	1413	2678	2395	8426	
		XPOL=	0.00	DB				
NO. SYST.	NOR.							TOTAL
MARG.	RATIO		0.16	0.74	1.32	0.65	2.19	
1	1.02		0	0	2678	0	8426	ANY 1
MARG.	RATIO			0.49	0.88	0.43	1.45	
2	1.02		634	938	1778	1590	5596	ANY 2
2	1.02		0	0	1278	0		ANY 2
MARG.	RATIO				0.66	0.32	1.09	
3	1.02		475	702	1331	1191	4189	ANY 3
3	1.02		0	0	0	0		ANY 3
MARG.	RATIO				0.52	0.26	0.87	
4	1.02		380	561	1064	951	3347	ANY 4
4	1.02		0.00	0.00	0	0	1343	
MARG.	RATIO					0.21	0.72	
5	1.02		316	467	886	792	2787	ANY 5
5	1.02		0.00	0.00	0.00	0	0	

TABLE 2.2

UPLINK: RAYLEIGH/DUAL DIVERSITY

SYS PARAM		CONST.	ELLIPSAT	GLOBAL	ODYSSEY	CELSAT
BIT RATE	KBPS	4.80	4.80	4.80	4.80	5.00
VOICE		0.50	0.50	0.50	0.50	0.50
BANDW.	MHZ	8.25	8.25	7.50	8.25	8.25
DIV LOSS	DB	1.00	1.00	1.00	1.00	1.00
E/(N+I)	DB	4.80	4.50	4.80	4.50	4.80
BEAMS		10.00	10.00	20.00	16.00	149.00
CLUSTER		1.00	1.00	1.00	1.00	1.00
AVG MARG.	DB	1.40	1.40	1.40	1.40	1.40
ORBIT/ANT	DB	2.90	2.00	1.29	1.50	1.70
POW CONT.	DB	1.50	1.00	1.00	1.00	2.00
BOF	DB	1.00	1.00	1.23	1.25	3.80
DY.RANGE	DB	1.10	7.90	10.40	7.40	12.70
MAX MARG.	DB	8.00	8.00	8.00	8.00	8.00
IDEAL CAP		9042	9688	16439	15501	129330
ASYM CAP		1889	2794	5295	4735	16661

SHARED CAPACITY

K	-228.60				
TEMP	500.00	26.99	DB/K		
FREQ	1.6183	GHZ			
GAIN	25.49				
NOISE	-140.10	DBW/M2 IN		4.00	KHZ

	PFD		CONST. LHC	ELLIPSAT RHC	GLOBAL RHC	ODYSSEY LHC	CELSAT LHC	
NO INTER	-143		640	947	1795	1605	5647	
		XPOL=	0.00	DB				
NO. SYST.	NOR.							TOTAL
MARG.	RATIO		0.20	0.98	1.74	0.87	2.95	
1	0.51		0	933	1795	1462	5647	ANY 1
MARG.	RATIO			0.73	1.30	0.65	2.20	
2	0.51		478	707	1340	1199	4218	ANY 2
2	0.51		0	0		0		ANY 2
MARG.	RATIO				1.04	0.52	1.76	
3	0.51		382	564	1070	957	3366	ANY 3
3	0.51		0	0		0		ANY 3
MARG.	RATIO				0.86	0.43	1.46	
4	0.51		317	470	890	796	2800	ANY 4
4	0.51		0.00	0.00	182	0		
MARG.	RATIO					0.37	1.25	
5	0.51		272	402	762	681	2397	ANY 5
5	0.51		0.00	0.00	0.00	0	5275	

TABLE 2.3

UPLINK:		DUAL DIVERSITY				
SYS PARAM		CONST.	ELLIPSAT	GLOBAL	ODYSSEY	CELSAT
BIT RATE	KBPS	4.80	4.80	4.80	4.80	5.00
VOICE		0.50	0.50	0.50	0.50	0.50
BANDW.	MHZ	8.25	8.25	7.50	8.25	8.25
DIV LOSS	DB	1.00	1.00	1.00	1.00	1.00
E/(N+I)	DB	4.80	4.50	4.80	4.50	4.80
BEAMS		10.00	10.00	20.00	16.00	149.00
CLUSTER		1.00	1.00	1.00	1.00	1.00
AVG MARG.	DB	1.40	1.40	1.40	1.40	1.40
ORBIT/ANT	DB	2.90	2.00	1.29	1.50	1.70
POW CONT.	DB	1.50	1.00	1.00	1.00	2.00
BOF	DB	1.00	1.00	1.23	1.25	3.80
DY.RANGE	DB	1.90	8.70	11.20	8.20	13.50
MAX MARG.	DB	8.00	8.00	8.00	8.00	8.00
IDEAL CAP		9042	9688	16439	15501	129330
ASYM CAP		1889	2794	5295	4735	16661

SHARED CAPACITY

K	-228.60				
TEMP	500.00	26.99	DB/K		
FREQ	1.6183	GHZ			
GAIN	25.49				
NOISE	-140.10	DBW/M2 IN		4.00	KHZ

	PFD	CONST. LHC	ELLIPSAT RHC	GLOBAL RHC	ODYSSEY LHC	CELSAT LHC	
NO INTER	-146	386	571	1083	968	3406	
	XPOL=	0.00	DB				
NO. SYST.	NOR.						TOTAL
MARG.	RATIO	0.25	1.17	2.09	1.05	3.55	
1	0.26	0	571	1083	968	3406	ANY 1
MARG.	RATIO	0.20	0.98	1.73	0.87	2.95	
2	0.26	321	474	899	804	2828	ANY 2
2	0.26	0	416		213		ANY 2
MARG.	RATIO	0.17	0.83	1.48	0.74	2.52	
3	0.26	274	405	768	687	2418	ANY 3
3	0.26	0	0		0		ANY 3
MARG.	RATIO	0.15	0.73	1.30	0.65	2.20	
4	0.26	239	354	671	600	2111	ANY 4
4	0.26	0.00	0.00	1724	0		
MARG.	RATIO		0.65	1.15	0.58	1.95	
5	0.26	212	314	596	533	1874	ANY 5
5	0.26	0.00	0.00	0.00	0		

Table 2.4

ARIES:				UPLINK	E.RADIUS =	6356.9	KM
PFD	DB/4K/M2	-140.0		-143.0		-146.0	
NO. SYSTS.	UNITS	1.0	2.0	1.0	2.0	1.0	2.0
FREQ	MHZ	1618.1	1618.1	1618.1	1618.1	1618.1	1618.1
POWER	MWATTS	774.0	774.0	604.4	774.0	502.0	603.8
SAFETY LIM	MWATTS	774.0	774.0	774.0	774.0	774.0	774.0
	DBW	-1.1	-1.1	-2.2	-1.1	-3.0	-2.2
POWER LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
ANT. GAIN	DBI	3.0	3.0	3.0	3.0	3.0	3.0
EIRP	DB	1.9	1.9	0.8	1.9	0.0	0.8
NO. USERS		92.00	1.00	63.40	42.50	36.60	32.10
DUTY CYCLE	%	50.0	50.0	50.0	50.0	50.0	50.0
U*D	DB	16.6	-3.0	15.0	13.3	12.9	12.1
EIRP/4KHZ	DB/4KHZ	-14.6	-34.3	-17.3	-18.0	-20.3	-20.3
EIRP/4K/M^2	DB	-140.35	-159.99	-143.04	-143.70	-146.00	-146.00
GAIN 1M2	DB	25.49	25.49	25.49	25.49	25.49	25.49
SAT. ALT.	KM	1020.0	1020.0	1020.0	1020.0	1020.0	1020.0
ELEV. ANG.	DEG	10.0	10.0	10.0	10.0	10.0	10.0
RE^2*COS^2		1103.9	1103.9	1103.9	1103.9	1103.9	1103.9
RANGE	KM	2798.3	2798.3	2798.3	2798.3	2798.3	2798.3
SPACE LOSS	DB	165.6	165.6	165.6	165.6	165.6	165.6
RX SIGNAL	DBW	-163.7	-163.7	-164.8	-163.7	-165.6	-164.8
MISC LOSS	DB	0.3	0.3	0.3	0.3	0.3	0.3
ANT. GAIN	DBI	7.9	7.9	7.9	7.9	7.9	7.9
PEAK GAIN	DBI	12.5	12.5	12.5	12.5	12.5	12.5
LINE LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
DATA RATE	BPS	4800.0	4800.0	4800.0	4800.0	4800.0	4800.0
	DB	36.8	36.8	36.8	36.8	36.8	36.8
EB	DBW/HZ	-192.9	-192.9	-194.0	-192.9	-194.8	-194.0
TOT.NOISE	DEG K	500.0	500.0	500.0	500.0	500.0	500.0
DENSITY,N0	DB	-201.6	-201.6	-201.6	-201.6	-201.6	-201.6
SELF INT.	DBW	-136.5	-156.1	-139.2	-139.8	-142.1	-142.1
AVG MARG.	DB	1.4	1.4	1.4	1.4	1.4	1.4
BEAM EFF.	DB	2.9	2.9	2.9	2.9	2.9	2.9
POW. CONT.	DB	1.5	1.5	1.5	1.5	1.5	1.5
BOF	DB	1.00	1.00	1.00	1.00	1.00	1.00
NMAI (Z)	DB	3.79	3.79	3.79	3.79	3.79	3.79
SELF INT.	DBW	-132.7	-152.3	-135.4	-136.0	-138.3	-138.3
SHARED INT	DBW		-132.3		-135.3		-138.3
TOT INTER.	DBW	-132.7	-132.3	-135.4	-132.7	-138.3	-135.3
BW	KHZ	8250.0	8250.0	8250.0	8250.0	8250.0	8250.0
	DB	69.2	69.2	69.2	69.2	69.2	69.2
DENSITY I0	DBW/HZ	-201.8	-201.4	-204.5	-201.8	-207.5	-204.5

Table 2.4 (cont.)

EB/N0	DB	8.72	8.72	7.65	8.72	6.84	7.64
EB/I0	DB	8.9	8.5	10.5	8.9	12.7	10.5
EB/(N0+I0)	DB	5.8	5.6	5.8	5.8	5.8	5.8
MODEM LOSS	DB	0.5	0.5	0.5	0.5	0.5	0.5
DIV LOSS	DB	1.0	1.0	1.0	1.0	1.0	1.0
REQ EB/N0	DB	4.3	4.3	4.3	4.3	4.3	4.3
AWGN MARGIN	DB	0.01	-0.19	0.05	0.00	0.04	0.02
FADE MARG.	DB	0.0	-0.2	1.1	0.0	1.9	1.1
NO. BEAMS		10.0	10.0	10.0	10.0	10.0	10.0
NO. SUB CH		1.0	1.0	1.0	1.0	1.0	1.0
TOTAL CHS.		920.0	10.0	634.0	425.0	366.0	321.0

Table 2.5

ELLIPSO:				UPLINK	E.RADIUS =	6356.9	KM
PFD	DB/4K/M2	-140.0		-143.0		-146.0	
	UNITS						
NO. SYSTS.		1.0	2.0	1.0	2.0	1.0	2.0
FREQ	MHZ	1618.1	1618.1	1618.1	1618.1	1618.1	1618.1
POWER	MWATTS	167.1	251.2	124.7	167.1	103.7	124.7
SAFETY LIM	MWATTS	774.0	774.0	774.0	774.0	774.0	774.0
	DBW	-7.8	-6.0	-9.0	-7.8	-9.8	-9.0
POWER LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
ANT. GAIN	DBI	3.0	3.0	3.0	3.0	3.0	3.0
EIRP	DB	-4.8	-3.0	-6.0	-4.8	-6.8	-6.0
NO. USERS		141.30	93.80	94.70	70.70	57.10	47.40
DUTY CYCLE	%	50.0	50.0	50.0	50.0	50.0	50.0
U*D	DB	18.5	16.7	16.8	15.5	14.6	13.7
EIRP/4KHZ	DB/4KHZ	-19.4	-19.4	-22.4	-22.4	-25.4	-25.4
EIRP/4K/M^2	DB	-140.06	-140.07	-143.07	-143.07	-146.07	-146.08
GAIN 1M2	DB	25.49	25.49	25.49	25.49	25.49	25.49
SAT. ALT.	KM	4000.0	4000.0	4000.0	4000.0	4000.0	4000.0
ELEV. ANG.	DEG	15.0	15.0	15.0	15.0	15.0	15.0
RE^2*COS^2		1645.3	1645.3	1645.3	1645.3	1645.3	1645.3
RANGE	KM	6695.1	6695.1	6695.1	6695.1	6695.1	6695.1
SPACE LOSS	DB	173.1	173.1	173.1	173.1	173.1	173.1
RX SIGNAL	DBW	-177.9	-176.1	-179.2	-177.9	-180.0	-179.2
MISC LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
ANT. GAIN	DBI	21.6	21.6	21.6	21.6	21.6	21.6
PEAK GAIN	DBI	25.0	25.0	25.0	25.0	25.0	25.0
LINE LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
DATA RATE	BPS	4800.0	4800.0	4800.0	4800.0	4800.0	4800.0
	DB	36.8	36.8	36.8	36.8	36.8	36.8
EB	DBW/HZ	-193.1	-191.3	-194.4	-193.1	-195.2	-194.4
TOT.NOISE	DEG K	500.0	500.0	500.0	500.0	500.0	500.0
DENSITY,N0	DB	-201.6	-201.6	-201.6	-201.6	-201.6	-201.6
SELF INT.	DBW	-134.8	-134.8	-137.8	-137.8	-140.8	-140.8
AVG MARG.	DB	1.4	1.4	1.4	1.4	1.4	1.4
BEAM EFF.	DB	2.0	2.0	2.0	2.0	2.0	2.0
POW. CONT.	DB	1.0	1.0	1.0	1.0	1.0	1.0
BOF	DB	1.00	1.00	1.00	1.00	1.00	1.00
NMAI (Z)	DB	2.39	2.39	2.39	2.39	2.39	2.39
SELF INT.	DBW	-132.4	-132.4	-135.4	-135.4	-138.4	-138.4
SHARED INT	DBW		-132.3		-135.3		-138.3
TOT INTER.	DBW	-132.4	-129.4	-135.4	-132.3	-138.4	-135.4
BW	KHZ	8250.0	8250.0	8250.0	8250.0	8250.0	8250.0
	DB	69.2	69.2	69.2	69.2	69.2	69.2
DENSITY I0	DBW/HZ	-201.6	-198.5	-204.6	-201.5	-207.6	-204.5

EB/N0	DB	8.54	10.31	7.27	8.54	6.47	7.27
EB/I0	DB	8.5	7.2	10.2	8.4	12.4	10.2
EB/(N0+I0)	DB	5.5	5.5	5.5	5.5	5.5	5.5
DIV LOSS	DB	1.0	1.0	1.0	1.0	1.0	1.0
MODEM LOSS	DB	0.5	0.5	0.5	0.5	0.5	0.5
REQ EB/N0	DB	4.0	4.0	4.0	4.0	4.0	4.0
AWGN MARGIN	DB	-0.01	-0.03	-0.02	-0.03	-0.02	-0.03
FADE MARG.	DB	6.7	4.9	7.9	6.6	8.7	7.9
NO. BEAMS		10.0	10.0	10.0	10.0	10.0	10.0
NO. SUB CH		1.0	1.0	1.0	1.0	1.0	1.0
TOTAL CHS.		1413.0	938.0	947.0	707.0	571.0	474.0

Table 2.6

GLOBALSTAR:				UPLINK			
PFD	DB/4K/M2	-140.0		-143.0		-146.0	
	UNITS						
NO. SYSTS.		1.0	2.0	1.0	2.0	1.0	2.0
FREQ	MHZ	1618.1	1618.1	1618.1	1618.1	1618.1	1618.1
POWER	MWATTS	94.4	142.2	70.5	94.4	58.7	70.8
SAFETY LIM	MWATTS	774.0	774.0	774.0	774.0	774.0	774.0
	DBW	-10.2	-8.5	-11.5	-10.2	-12.3	-11.5
POWER LOSS	DB	1.0	1.0	1.0	1.0	1.0	1.0
ANT. GAIN	DBI	3.0	3.0	3.0	3.0	3.0	3.0
EIRP	DB	-8.2	-6.5	-9.5	-8.2	-10.3	-9.5
NO. USERS		22.32	14.82	14.96	11.17	9.03	7.49
DUTY CYCLE	%	50.0	50.0	50.0	50.0	50.0	50.0
U*D	DB	10.5	8.7	8.7	7.5	6.5	5.7
EIRP/4KHZ	DB/4KHZ	-22.7	-22.7	-25.7	-25.7	-28.7	-28.7
EIRP/4K/M^2	DB	-140.00	-140.00	-143.00	-143.00	-145.99	-145.99
GAIN 1M2	DB	25.49	25.49	25.49	25.49	25.49	25.49
SAT. ALT.	KM	1389.0	1389.0	1389.0	1389.0	1389.0	1389.0
ELEV. ANG.	DEG	90.0	90.0	90.0	90.0	90.0	90.0
RANGE	KM	1389.0	1389.0	1389.0	1389.0	1389.0	1389.0
SPACE LOSS	DB	159.5	159.5	159.5	159.5	159.5	159.5
RX SIGNAL	DBW	-167.7	-166.0	-169.0	-167.7	-169.8	-169.0
POL. LOSS	DB	0.5	0.5	0.5	0.5	0.5	0.5
TRACK LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
ANT. GAIN	DBI	13.3	13.3	13.3	13.3	13.3	13.3
PEAK GAIN	DBI	15.6	15.6	15.6	15.6	15.6	15.6
LINE LOSS	DB	1.0	1.0	1.0	1.0	1.0	1.0
DATA RATE	BPS	4800.0	4800.0	4800.0	4800.0	4800.0	4800.0
	DB	36.8	36.8	36.8	36.8	36.8	36.8
EB	DBW/HZ	-192.7	-190.9	-194.0	-192.7	-194.8	-194.0
TOT.NOISE	DEG K	500.0	500.0	500.0	500.0	500.0	500.0
DENSITY,N0	DB	-201.6	-201.6	-201.6	-201.6	-201.6	-201.6
SELF INT.	DBW	-142.4	-142.4	-145.4	-145.4	-148.4	-148.4
AVG MARG.	DB	1.4	1.4	1.4	1.4	1.4	1.4
BEAM EFF.	DB	1.3	1.3	1.3	1.3	1.3	1.3
POW. CONT.	DB	1.0	1.0	1.0	1.0	1.0	1.0
BOF	DB	1.2	1.2	1.2	1.2	1.2	1.2
NMAI (Z)	DB	1.91	1.91	1.91	1.91	1.91	1.91
SELF INT.	DBW	-140.5	-140.5	-143.5	-143.5	-146.5	-146.5
SHARED INT	DBW		-140.5		-143.5		-146.5
TOT INTER.	DBW	-140.5	-137.5	-143.5	-140.5	-146.5	-143.5
BW	KHZ	1250.0	1250.0	1250.0	1250.0	1250.0	1250.0
	DB	61.0	61.0	61.0	61.0	61.0	61.0

Table 2.6 (cont.)

DENSITY I0	DBW/HZ	-201.5	-198.5	-204.5	-201.5	-207.5	-204.5
EB/N0	DB	8.91	10.69	7.64	8.91	6.85	7.66
EB/I0	DB	8.8	7.5	10.5	8.8	12.7	10.5
EB/(N0+I0)	DB	5.8	5.8	5.8	5.8	5.8	5.8
DIV LOSS	DB	1.0	1.0	1.0	1.0	1.0	1.0
MODEM LOSS	DB	0.5	0.5	0.5	0.5	0.5	0.5
REQ EB/N0	DB	4.3	4.3	4.3	4.3	4.3	4.3
AWGN MARGIN	DB	0.02	0.02	0.03	0.02	0.04	0.04
FADE MARG.	DB	9.2	7.4	10.4	9.2	11.2	10.4
NO. BEAMS		20.0	20.0	20.0	20.0	20.0	20.0
NO. SUB CH		13.0	13.0	13.0	13.0	13.0	13.0
TOTAL CHS.		5802.3	3852.3	3889.2	2903.3	2346.5	1947.8

Table 2.7

ODYSSEY:				UPLINK	E.RADIUS	6356.9	KM
PFD	DB/4K/M2	-140.0		-143.0		-146.0	
NO. SYSTS.	UNITS	1.0	2.0	1.0	2.0	1.0	2.0
FREQ	MHZ	1618.1	1618.1	1618.1	1618.1	1618.1	1618.1
POWER	MWATTS	190.1	285.0	142.2	190.1	117.7	141.2
SAFETY LIM	MWATTS	774.0	774.0	774.0	774.0	774.0	774.0
	DBW	-7.2	-5.5	-8.5	-7.2	-9.3	-8.5
POWER LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
ANT. GAIN	DBI	3.0	3.0	3.0	3.0	3.0	3.0
EIRP	DB	-4.2	-2.5	-5.5	-4.2	-6.3	-5.5
NO. USERS		149.69	99.38	100.31	74.94	60.50	50.25
DUTY CYCLE	%	50.0	50.0	50.0	50.0	50.0	50.0
U*D	DB	18.7	17.0	17.0	15.7	14.8	14.0
EIRP/4KHZ	DB/4KHZ	-18.6	-18.6	-21.6	-21.6	-24.6	-24.6
EIRP/4K/M^2	DB	-140.00	-140.02	-143.00	-143.00	-146.02	-146.03
GAIN 1M2	DB	25.49	25.49	25.49	25.49	25.49	25.49
SAT. ALT.	KM	10500.0	10500.0	10500.0	10500.0	10500.0	10500.0
ELEV. ANG.	DEG	20.0	20.0	20.0	20.0	20.0	20.0
RE^2*COS^2		2174.2	2174.2	2174.2	2174.2	2174.2	2174.2
RANGE	KM	13588.8	13588.8	13588.8	13588.8	13588.8	13588.8
SPACE LOSS	DB	179.3	179.3	179.3	179.3	179.3	179.3
RX SIGNAL	DBW	-183.5	-181.7	-184.8	-183.5	-185.6	-184.8
MISC LOSS	DB	0.3	0.3	0.3	0.3	0.3	0.3
ANT. GAIN	DBI	27.6	27.6	27.6	27.6	27.6	27.6
PEAK GAIN	DBI	30.2	30.2	30.2	30.2	30.2	30.2
LINE LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
DATA RATE	BPS	4800.0	4800.0	4800.0	4800.0	4800.0	4800.0
	DB	36.8	36.8	36.8	36.8	36.8	36.8
EB	DBW/HZ	-193.0	-191.3	-194.3	-193.0	-195.1	-194.3
T0T.NOISE	DEG K	500.0	500.0	500.0	500.0	500.0	500.0
DENSITY,N0	DB	-201.6	-201.6	-201.6	-201.6	-201.6	-201.6
SELF INT.	DBW	-134.5	-134.5	-137.5	-137.5	-140.5	-140.5
AVG MARG.	DB	1.4	1.4	1.4	1.4	1.4	1.4
BEAM EFF.	DB	1.5	1.5	1.5	1.5	1.5	1.5
POW. CONT.	DB	1.0	1.0	1.0	1.0	1.0	1.0
BOF	DB	1.25	1.25	1.25	1.25	1.25	1.25
NMAI (Z)	DB	2.14	2.14	2.14	2.14	2.14	2.14
SELF INT.	DBW	-132.3	-132.3	-135.3	-135.3	-138.3	-138.4
SHARED INT	DBW		-132.3		-135.3		-138.3
TOT INTER.	DBW	-132.3	-129.3	-135.3	-132.3	-138.3	-135.3
BW	KHZ	8250.0	8250.0	8250.0	8250.0	8250.0	8250.0
	DB	69.2	69.2	69.2	69.2	69.2	69.2

Table 2.7 (cont.)

DENSITY I0	DBW/HZ	-201.5	-198.5	-204.5	-201.5	-207.5	-204.5
EB/N0	DB	8.61	10.37	7.35	8.61	6.52	7.32
EB/I0	DB	8.5	7.2	10.2	8.5	12.4	10.2
EB/(N0+I0)	DB	5.5	5.5	5.5	5.5	5.5	5.5
DIV LOSS	DB	1.0	1.0	1.0	1.0	1.0	1.0
MODEM LOSS	DB	0.5	0.5	0.5	0.5	0.5	0.5
REQ EB/N0	DB	4.0	4.0	4.0	4.0	4.0	4.0
AWGN MARGIN	DB	0.02	0.00	0.03	0.02	0.02	0.00
FADE MARG.	DB	6.1	4.3	7.4	6.1	8.2	7.4
NO. BEAMS		16.0	16.0	16.0	16.0	16.0	16.0
NO. SUB CH		1.0	1.0	1.0	1.0	1.0	1.0
TOTAL CHS.		2395.0	1590.0	1605.0	1199.0	968.0	804.0

Table 2.8

CELSTAR:				UPLINK	E.RADIUS	6356.9	KM
PFD	DB/4K/M2	-140.0		-143.0		-146.0	
	UNITS						
NO. SYSTS.		1.0	2.0	1.0	2.0	1.0	2.0
FREQ	MHZ	1618.1	1618.1	1618.1	1618.1	1618.1	1618.1
POWER	MWATTS	56.5	83.2	41.7	55.9	34.7	41.7
SAFETY LIM	MWATTS	774.0	774.0	774.0	774.0	774.0	774.0
	DBW	-12.5	-10.8	-13.8	-12.5	-14.6	-13.8
POWER LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
ANT. GAIN	DBI	3.0	3.0	3.0	3.0	3.0	3.0
EIRP	DB	-9.5	-7.8	-10.8	-9.5	-11.6	-10.8
NO. USERS		56.55	37.56	37.90	28.31	22.86	18.96
DUTY CYCLE	%	50.0	50.0	50.0	50.0	50.0	50.0
U*D	DB	14.5	12.7	12.8	11.5	10.6	9.8
EIRP/4KHZ	DB/4KHZ	-28.1	-28.2	-31.2	-31.2	-34.2	-34.2
EIRP/4K/M^2	DB	-140.01	-140.10	-143.07	-143.06	-146.07	-146.06
GAIN 1M2	DB	25.49	25.49	25.49	25.49	25.49	25.49
SAT. ALT.	KM	40000.0	40000.0	40000.0	40000.0	40000.0	40000.0
ELEV. ANG.	DEG	31.0	31.0	31.0	31.0	31.0	31.0
RE^2*COS^2		3274.0	3274.0	3274.0	3274.0	3274.0	3274.0
RANGE	KM	42761.5	42761.5	42761.5	42761.5	42761.5	42761.5
SPACE LOSS	DB	189.2	189.2	189.2	189.2	189.2	189.2
RX SIGNAL	DBW	-198.7	-197.0	-200.0	-198.8	-200.9	-200.0
MISC LOSS	DB	0.3	0.3	0.3	0.3	0.3	0.3
ANT. GAIN	DBI	43.3	43.3	43.3	43.3	43.3	43.3
PEAK GAIN	DBI	46.2	46.2	46.2	46.2	46.2	46.2
LINE LOSS	DB	0.0	0.0	0.0	0.0	0.0	0.0
DATA RATE	BPS	5000.0	5000.0	5000.0	5000.0	5000.0	5000.0
	DB	37.0	37.0	37.0	37.0	37.0	37.0
EB	DBW/HZ	-192.7	-191.1	-194.1	-192.8	-194.9	-194.1
TOT.NOISE	DEG K	500.0	500.0	500.0	500.0	500.0	500.0
DENSITY,N0	DB	-201.6	-201.6	-201.6	-201.6	-201.6	-201.6
SELF INT.	DBW	-138.2	-138.3	-141.3	-141.3	-144.3	-144.3
AVG MARG.	DB	1.4	1.4	1.4	1.4	1.4	1.4
BEAM EFF.	DB	1.7	1.7	1.7	1.7	1.7	1.7
POW. CONT.	DB	2.0	2.0	2.0	2.0	2.0	2.0
BOF	DB	3.80	3.80	3.80	3.80	3.80	3.80
NMAI (Z)	DB	5.89	5.89	5.89	5.89	5.89	5.89
SELF INT.	DBW	-132.3	-132.4	-135.4	-135.4	-138.4	-138.4
SHARED INT	DBW		-132.3		-135.3		-138.3
TOT INTER.	DBW	-132.3	-129.4	-135.4	-132.3	-138.4	-135.3
BW	KHZ	8250.0	8250.0	8250.0	8250.0	8250.0	8250.0
	DB	69.2	69.2	69.2	69.2	69.2	69.2
DENSITY I0	DBW/HZ	-201.5	-198.5	-204.6	-201.5	-207.6	-204.5

Table 2.8 (cont.)

EB/N0	DB	8.90	10.58	7.58	8.85	6.77	7.58
EB/I0	DB	8.8	7.5	10.5	8.7	12.7	10.5
EB/(N0+I0)	DB	5.8	5.7	5.8	5.8	5.8	5.8
DIV LOSS	DB	1.0	1.0	1.0	1.0	1.0	1.0
MODEM LOSS	DB	0.5	0.5	0.5	0.5	0.5	0.5
REQ EB/N0	DB	4.3	4.3	4.3	4.3	4.3	4.3
AWGN MARGIN	DB	0.02	-0.05	-0.01	-0.02	-0.02	-0.02
FADE MARG.	DB	11.4	9.6	12.7	11.4	13.5	12.7
NO. BEAMS		149.0	149.0	149.0	149.0	149.0	149.0
NO. SUB CH		1.0	1.0	1.0	1.0	1.0	1.0
TOTAL CHS.		8426.0	5596.0	5647.1	4217.9	3406.0	2828.0

TABLE 2.9

CDMA APPLICANTS

UPLINK:

SYS PARAM		CONST.	ELLIPSAT	GLOBAL	ODYSSEY	CELSAT
BIT RATE	KBPS	4.80	4.80	4.80	4.80	5.00
VOICE		0.50	0.40	0.50	0.40	0.35
BANDW.	MHZ	8.25	8.25	7.50	8.25	8.25
DIV LOSS	DB	0.00	0.00	0.00	0.00	0.00
E/(N+I)	DB	4.00	4.50	4.80	4.50	4.00
BEAMS		10.00	10.00	20.00	16.00	149.00
CLUSTER		1.00	1.00	1.00	1.00	1.00
AVG MARG.	DB	1.70	1.50	1.00	1.30	1.00
ORBIT/ANT	DB	2.90	2.00	1.29	1.50	1.70
POW CONT.	DB	1.50	1.00	1.00	1.00	2.00
BOF	DB	1.00	1.00	1.23	1.25	3.80
IDEAL CAP		13685	15246	20896	24393	279842
ASYM CAP		2668	4297	7309	7626	39500

SHARED CAPACITY

K	-228.60				
TEMP	500.00	26.99	DB/K		
FREQ	1.6183	GHZ			
GAIN	25.49				
NOISE	-140.10	DBW/M2 IN		4.00	KHZ

	PFD	CONST.	ELLIPSAT	GLOBAL	ODYSSEY	CELSAT
		LHC	RHC	RHC	LHC	LHC
NO INTER	-140	1349	2173	3696	3856	19976

XPOL= 0.00 DB

NO. SYST.							TOTAL
1	1.02	1349	2173	3696	3856	19976	ANY 1
2	1.02	896	1443	2455	2561	13267	ANY 2
3	1.02	671	1080	1838	1917	9931	ANY 3
4	1.02	536	863	1469	1532	7936	ANY 4
5	1.02	446	719	1223	1276	6608	ANY 5
6	1.02	382	616	1048	1093	5661	ANY 6

ANNEX 5.3

Non-CONUS U.S. Capacity

The Iridium system covers all areas in the world with essentially the same performance level that it provides over CONUS, and all capacities shown in this section are in addition to the CONUS capacities listed above.

The relevant parameters for determining non-CONUS U.S. capacities are as follows:

B = 20, C = 6, for Alaska;
B = 2, C = 3, for Hawaii;
B = 1, C = 6, each, for Puerto Rico and the American Virgin Islands;
B = 1, C = 2, each, for Guam, Wake Island and American Samoa.

The following tables set forth the capacities of multiple FDMA/TDMA systems for several specified non-CONUS U.S. states and territories.

Table A5.3.1
Alaskan Capacity of Multiple FDMA/TDMA IRIDIUM Type Systems in 8.25 MHz

Number of MSS systems	Capacity-Channels (per system)
1	1308
2	646
3	426
4	313

Table A5.3.2
Hawaiian Capacity of Multiple FDMA/TDMA IRIDIUM Type Systems in 8.25 MHz

Number of MSS systems	Capacity-Channels (per system)
1	261
2	129
3	85
4	62

Table A5.3.3
Puerto Rico or American Virgin Island Capacity of Multiple FDMA/TDMA IRIDIUM Type Systems in 8.25 MHz

Number of MSS systems	Capacity-Channels (per system)
1	65
2	32
3	21
4	13

Table A5.3.4
Guam, Wake Island, or American Samoa Capacity of Multiple FDMA/TDMA IRIDIUM Type Systems in 8.25 MHz

Number of MSS systems	Capacity-Channels (per system)
1	195
2	96
3	63
4	39

Total capacity and spectral efficiency figures for the entire United States are summarized in Tables A5.3.5 and A5.3.6.

Table A5.3.5
Total US and US Territory Capacity of Multiple FDMA/TDMA IRIDIUM Type Systems in 8.25 MHz

Number of MSS systems	Capacity-Channels (per system)
1	6203
2	3034
3	2000
4	1455

Table A5.3.6
Spectral Efficiency of Multiple FDMA/TDMA IRIDIUM-Type Systems for Total US and US Territories

Number of MSS Systems	Spectral Efficiency Channels per MHz
1	751
2	735
3	727
4	705

6.0 Proposed System Adjustments to Optimize Capacity

Section 6.1 describes for each participating system the suggested refinements in its system design used in Section 5. Section 6.2 addresses parameters which could be adjusted at later stages in order to improve system performance beyond that described in 6.1.

6.1 Differences Between System Parameters in Section 5 and Initial System Descriptions

(a) AMSC

AMSC initially applied to extend its existing planned FDMA services into the RDSS band by matching the 1610-1626.5 MHz uplink with an L- or S-band downlink that would permit it to operate its FDMA carriers without modification. When the FCC rejected the suggestion to match the uplink with another downlink band, AMSC recognized that the use of the 2483.5-2500 band would require the use of some form of spectrum spreading to operate below the PFD threshold of RR 2566. In addition to this, it was recognized that operating in an interference sharing environment would require further modifications to operate compatibly and generate sufficient capacity to rationalize the construction of a geostationary satellite. Thus, AMSC is considering the following modifications to its satellite system for operation in an interference sharing environment.

An increase in the spacecraft antenna reflector to 8.3 meters in diameter to generate 6 CONUS coverage beams;

A 3 x 5.5 MHz spacecraft channelization plan to operate compatibly with other CDMA systems operating in the band;

The use of coherent demodulation in the forward and reverse links; and,

The use of individual link power control in the forward and reverse links.

Thus, AMSC will primarily provide service to vehicular terminals. AMSC terminal EIRP capabilities will not be restricted by the EIRP limitations associated with handheld terminals, since it is vehicle mounted.

(b) Celsat

Celsat feels that no design changes are necessary to its planned system to accommodate sharing.

(c) Constellation

Constellation has indicated that several changes are currently planned to its system to improve its ability to share spectrum and increase capacity. The two most significant changes are the reconfiguration of its satellite antennas from a single-beam to a multiple-beam (e.g. 7 beam) design, and the modification of its uplink mobile earth station transmission format to include spreading over a 1 to 5 MHz bandwidth.

(d) Ellipsat

Ellipsat Corporation has made several changes to the Ellipso system design in order to improve performance. These changes reflect best current thinking, but remain subject to change. These changes include:

- The Ellipso satellite will now use a 37-beam array on uplinks and downlinks in order to accurate placement of PFD.

- Ellipso will spread user signals over the full 16.5 MHz band, or as much of it as is available for use.

- The feeder link formats will be changed to accommodate service link changes.

(e) LQSS

(1) Antenna patterns. In reviewing its system parameters for the analysis in Section 5.1, LQSS has used 12 beams per satellite to enhance its system design in the proposed sharing environment with other CDMA systems. The increased number of beams increases the antenna gain and the link budgets change accordingly. This represents an increase from the application value of 6. Analysis of the optimum number of beams for each satellite will continue as the sharing criteria are developed further and the technical requirements imposed upon MSS licensees are established.

(2) Satellite/gateway links. The satellite to gateway links contribute to overall Eb/No. On the return link the satellite to gateway link was a major contributor to the overall Eb/No values in the application. Accordingly, for the analysis in Section 5.1, LQSS has assumed that its system will be designed such that the C-band link from the satellite to the gateway is not a capacity limiting factor in the system.

(3) Orbital altitude. In its application, LQSS stated a value of 1389 km. The design to facilitate the simulation of the sharing depicted in Section 5.1 uses 1414 km.

(f) Motorola

The Iridium system was analyzed with the following changes in parameters to its current system design:

(1) an increase in reuse of spatial separation (6 vs. 12 beam reuse cluster); and

(2) additional antenna isolation to mitigate interference as may be required by the rules.

(g) TRW

In order to improve the efficiency of usage of the scarce orbit/spectrum resource, while operating in a full-band interference sharing environment, TRW has considered changing some of the parameters of the ODYSSEY system, a outlined below. These changes permit the ODYSSEY system to fully exploit the advantages of CDMA, essentially by providing greater frequency re-use and hence higher spectral efficiency:

	Currently Proposed
Eb/No	4.5 dB uplink (from 5.3) 3.5 dB downlink
Beam Frequency Reuse Factor	1 (from 3)
Spread Bandwidth	16.5 MHz or full available band (from 5.5 MHz)

6.2 Further Improvements Achievable

Section 5 of this report contains an analysis of the operation of the MSS systems as currently designed, with some enhancements to facilitate efficient operation in a sharing environment. Each of the proposed systems was originally conceived without a knowledge of the sharing environment (i.e. how many systems might be sharing the spectrum, and what coordination rules might be adopted). The following section describes some improvements which may be used to enable the systems to share the spectrum more efficiently in order to increase system capacity.

6.2.1 First Generation Improvements

6.2.1.1 Satellite Antenna Design

As is clear from the equations developed in Section 5, the capacity of MSS systems in a sharing environment is directly related to the size and number of antenna beams a system employs on its satellites. This is due to a more efficient frequency reuse factor. If a system doubles the number of beams that cover a given region on the ground, there is a nearly proportional increase in capacity, since all frequency channels can be used again in all the new beams. This holds true for both the uplink and downlink.

In developing the analysis for Section 5, several applicants have indicated that they would use more beams to increase capacity in the proposed sharing environment; some applicants have indicated that this could occur during a coordination process. At present, all of the applicants which have proposed CDMA techniques have based their capacity analysis on 37 or fewer beams per satellite. Other applicants, however, have said that as many as 48 beams are feasible on a LEO satellite, or up to 150 on a geostationary satellite.

This design parameter must be left flexible to respond to market forces since there is a tradeoff between system cost vs. capacity.

6.2.1.2 Use of Polarization Isolation

Overall, given the polarization isolation levels reflected in Section 5, a reasonable improvement in shared system capacity is possible. All of the CDMA system proponents have said they intend to use polarization isolation to maximize shared system capacity.

6.2.1.3 Sharing with Smaller Systems

For the interference sharing analysis of Section 5, it was assumed that all systems used approximately the same operating point for both downlink PFD spectral density and uplink aggregate EIRP areal spectral density.

Some applicants may decide to introduce smaller, lower capacity, less expensive systems that would operate at lower interfering power levels than is assumed for the cases analyzed in Section 5. This reduced interference contribution would enable the other systems to operate with more channels.

6.2.1.4 Improvement of Simplified Sharing Models in Section 5

The system capacities derived in Section 5 were based on simplified models which, in several cases, used overly conservative assumptions relative to what would actually be done during an actual coordination process. In operation, the "degraders" and the interference will not be as severe as shown in the analysis in Section 5.

For example, an improvement in downlink capacity will be realized when the statistical nature of the interference is taken account of. The simplified analysis assumed that the interference was at the maximum PFD value at all times and in all places in the coverage area. In practice, the interference will, on average, be below this value, and this statistical average will result in less average interfering PFD and hence greater system capacity. Considering that the main contributor to this effect is "orbit and beam effects," which has a typical average value of 2 to 3 dB, this is likely to result in an average reduction in interference of 1 to 2 dB.

6.2.2 Future System Enhancements

There are several other system improvements that have been proposed for future implementation in a sharing environment.

6.2.2.1 Improved Vocoders

It is reasonable to expect that vocoder technology will continue to improve. As a result, quality voice service would be attainable with lower bit rates and attendant capacity increases.

6.2.2.2 Improved Modulation

A similar situation is possible with future improvements in modem technology. By allowing access to the full band, future systems are constrained only by total power, and can choose to use that power in the most efficient way. If more efficient modulation formats are able to be used, either wide or narrowband, that make possible lower energy levels per user, more users can be supported. A system could use part of its power (interference) allocation to start users with the new modulation, while the rest would be used to support older users. Some of these modulation improvements will require access to a large portion of the MSS band.

7.0 EFFECTS OF SHARING WITH SERVICES OTHER THAN MSS/RDSS

7.1 Introduction

IWG2 was tasked with considering spectrum sharing solutions with services other than MSS/RDSS. The sharing solutions recommended by IWG2 and the interference from other services reported by IWG2 may restrict MSS system capacity, performance and service areas.

7.2 Sharing with Radio Astronomy

The Radio Astronomy Service (RAS) operates 14 observatories in the United States in the 1610.6-1613.8 MHz band. In addition, there are 16 other RAS sites outside of the United States operating in this band. In any given year, Radio Astronomy (RA) observations occur approximately 25% of the time in the 1610.6-1613.8 MHz band.

7.2.1 Protection Zones for MSS Operators in the 1610.6-1613.8 MHz Band

IWG2 proposes protection zones as the principal means for MSS operators in the 1610.6-1613.8 MHz band to share with the RAS. Co-frequency operation within the protection zones during periods of radio astronomy operation would be prohibited. The RA community has agreed to provide MSS operators with an advance schedule of their observations.

IWG2 proposes protection zones of 100 mile radius around five RA sites: Arecibo, Puerto Rico; Green Bank, West Virginia; VLA (San Augustin, New Mexico); Owens Valley, California; and Ohio State University, Ohio.

IWG2 also recommends protection zones of 30 mile radius around ten Very Large Baseline Array (VLBA) RA sites in the United States listed in Section 3, Table 1 of the IWG2A report.

IWG2 recognizes that, in the future, it may be possible to replace the fixed protection zones with beacon protection zones.